Changing the way you protect and manage your machinery

Proper use of seismic housing measurements

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On many machines, with different bearing types, in both normal and malfunction situations, the shaft relative probe provides the best measurement of dynamic motion (vibration). The nontouching eddy current probe used for shaft relative (to the housing) measurement can also read at zero frequency, a measurement which all housing inertially-referenced transducers cannot provide. Therefore, shaft relative probes yield vital slow roll data for vastly improved balancing and many other purposes.

Housing vibration transducers

However, there are also several very appropriate uses of housing vibration transducers. Typically, these are:

- As a supplement to REBAM® probes for primary vibration measurement from rolling element bearings, when placed close to the bearing.
- As a supplement to shaft relative probes, to measure the vibration of fluid-lubricated bearing machines when the dynamic stiffnesses of bearings are being observed.
- To measure vibration on housings with very low dynamic stiffness, such as on strut-supported gas turbine bearings.
- To measure housing vibration on machines with support structures that may become too weak during a malfunction condition because of loose grout or liftoff from the foundation due to thermal bowing. Similarly, to measure housing vibration during malfunction conditions in which the bearing dynamic stiffness becomes too high, as with a cocked bearing.
- When it is not possible or practical to install shaft relative motion transducers, i.e., some hermetically-sealed pumps and compressors.

The Bently Nevada Velomitor® is an excellent choice for many of these applications. Since it is a piezo-accelerometer transducer with a single integration, its primary output is velocity. It is usually calibrated in zero-to-peak inches (or millimeters) per second for rotating and reciprocating machinery work. (When doing acoustical studies, however, root mean square readout may be useful.) Velomitors are often used in XY pairs (mounted radially with a 90° separation) as housing transducers, and also in XYZ groups where axial vibration measurements are useful.

There is another disadvantage to housing motion measurements in addition to the loss of steady-state centerline position that was previously mentioned. The reading of any housing transducer is very dependent on the dynamic stiffness of the housing at the point where the housing transducer is located. A force from the rotor will have a large effect on a housing transducer located at a very low stiffness (compliant) point near the bearing, but a small effect on a housing transducer located on a significant mass, or near a stiff attachment to a solid foundation. For example, a sinusoidal force of 100 pounds (445 N) zero-to-peak at some frequency would produce a reading of 1 mil (25 μm) if the housing stiffness at the location of the housing transducer were 100,000 lbs/in (17.5 x 10^6 N/m), and a reading of .10 mils (2.5 μm) if the housing stiffness were 1,000,000 lbs/in (1.75 x 10^8 N/m) at that same frequency. Obviously, because the dynamic stiffness at the location of the housing transducer is rarely known, housing measurements have always been difficult to tie to the severity of the condition.

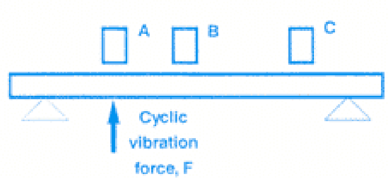

Figure 1
A, B & C are housing vibration transducers with the same sensitivity

We now have a simple way to greatly improve the meaning of housing measurements: **force calibration of housing dynamic motion transducers**.

In Figure 1, each housing transducer (with the same sensitivity) will read a different vibration level, due to the vibration force, F. For acoustic measurements, that is probably what you want. For machinery performance information, however, it is usually important to know the characteristics (amplitude, phase and frequency) of the forces acting on the machine. To accomplish this, the housing transducers are attached, then the housing is tested across the frequency range of interest (usually low speed to three or four times rotative speed) with a force of known amplitude and phase. The force calibration of each transducer is made by dividing the input force by the reading of the transducer across the frequency range. This Vector Dynamic Stiffness is memorized for each transducer location.

The observed readings of each housing transducer can (1) be used as usual, (2) (much more vitally) be multiplied by the stored Vector Dynamic Stiffness to indicate the amount of force at that point that has not been absorbed by the local housing mass.

This approach represents a paradigm shift in the way we look at seismic housing vibration and is a vast improvement over seismic only measurement. Force measurement will encourage industry to develop new techniques which will replace simple vibration severity charts with a more effective practice.

Bently Nevada's Machinery Diagnostic Services group can assist you with the initial or periodic measurement of the Vector Dynamic Stiffnesses on your Velomitor® installation. Note that a change in a Vector Dynamic Stiffness may, itself, be a direct indication of a machinery problem. ■